Biological Design Criteria for New Hydropower Turbines: Biological Response Relationships

Water Power Technologies

Oak Ridge National Laboratory (ORNL) supports the Department of Energy's (DOE) mission for research and development through testing, evaluation and demonstration. These goals are achieved by deploying innovative technologies capable of generating renewable, environmentally responsible, cost-effective energy from water resources. Through these efforts, ORNL supports hydropower research and market acceleration.

Passage of fish through turbines, like those on McNary Dam on the Columbia River, can cause fish injury or death via turbine blade strike, rapid pressure drops, and water turbulence.

Passage of fish through hydropower turbines is a common occurrence for many fishes, such as these gizzard shad.

The Department of Energy is working towards understanding the forces at the root of these injuries to help turbine manufacturers minimize damaging physical forces to fish. Ultimately, the goal is to integrate engineering and fish biology to minimize losses to fish populations through understanding the fish response to turbine passage.

Creating fish-friendly hydropower

Dams and hydropower are major players in the decline of many fish populations. Although the exact mechanisms of these declines vary by region and fish species, creating engineering solutions responsive to the biological needs of fish is one strategy for reducing the environmental impact of hydropower and increasing its environmental sustainability.

Fish move through dams

Fish commonly move downstream through dams passing either through hydropower turbines or spillgates. This passage can be dangerous and fish can be hit by turbine blades, lose scales and skin in boiling waters, and undergo extremely rapid pressure decreases that can damage organs. Depending on the fish species, turbine injury and mortality can even cause significant harm to fish populations.

Moving through dams is stressful

To truly understand what happens to fish as they move through a hydropower turbine, we have to study fish in the lab. Why is this?

It is common for young native fish like this two-week old paddlefish to pass through hydropower turbines.

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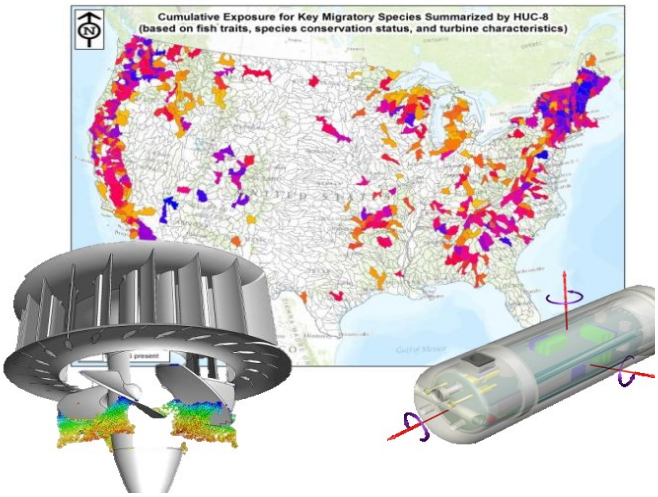
Incorporating the biological needs of native species like this American eel is one focal point of this project.



Using state-of-the-art sensors and other technologies we can understand where and how more fish-friendly hydropower is possible.

In reality, when fish pass through turbines, they encounter multiple stressors such as being hit by turbine blades and rapid pressure drops all at once. To reduce stresses on fish, we need to first understand which individual stressors cause particular types of injuries which requires studying each stressor separately. In the laboratory, we can control both the type of stressor and dose (i.e., strength and duration) of the stressor. For instance, our ability to control conditions in the laboratory allows us to be able to examine a range of forces that represents the range fish are subjected to as they pass through a turbine and evaluate injuries that occur as a result of that force. Initial experimental studies will focus on the effects of blade strike on injury severity and the effects of shear stresses on descaling.

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